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ABSTRACT

This investigation was conducted to determine the effects of a 10-day summer workshop using the Concerns Based Adoption Model concerning science technology and society (STS) topics and methods of classroom implementation on the knowledge, attitudes, and stages of concerns of the participating secondary inservice teachers, as well as student impacts. The study was conducted using a modified pretest-posttest control group design. Participating and control group teachers were pretested prior to 10 days (70 hours) of instruction and posttested at the end. The participating teachers implemented a 10-day STS unit into their traditional classrooms and pre- and posttested their students and the control group. Teacher knowledge and attitude was evaluated using instruments designed by the investigations. Covariant analysis was used to evaluate the effects of the treatment. The participating teacher concerns were significantly changed in the following stages: awareness, informational, consequence, collaboration, and refocusing. The attitudes of the teachers who participated were significantly increased in the direction judged to be positive when compared to the control group. The results of this investigation indicated that a 10-day summer inservice workshop can be effective in reducing non- and beginning user teacher concerns, increasing content knowledge and approach tendencies toward STS topics. (Author/MVL)

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THE EFFECTS OF A SUMMER INSERVICE PROGRAM ON SECONDARY SCIENCE TEACHERS' STAGES OF CONCERNS, ATTITUDES, AND KNOWLEDGE OF SELECTED STS CONCEPTS AND ITS IMPACT ON STUDENTS' KNOWLEDGE[1]

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[1] This research was partially supported by the Pennsylvania Science Teacher Education Program (PA STEP).

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ABSTRACT

This investigation was to determine the effects of a 10-day summer workshop using the Concerns Based Adoption Model concerning Science Technology & Society topics and methods of classroom implementation on the knowledge, attitudes, and stages of concerns of the participating secondary inservice teachers, as well as student impacts. This study was conducted using a modified pretest-posttest control group design. Participating teachers were pretested prior to 10 days (70 hrs.) of instruction and posttested at the end. The control group were tested within a similar period of time. Simultaneous testing was not possible due to the inavailability of teachers during the summer. The participating teachers implemented a 10-day STS unit into their traditional classrooms and pre- and posttested their students and the control group. Teacher knowledge and attitude was evaluated using instruments designed by the investigators. The Stages of Concerns Questionnaire is an established instrument. Covariant analysis was used to evaluate the effects of the treatment at the .05 level of significance. The participating teacher concerns were significantly changed in the following stages: Awareness; Informational; Consequence; Collaboration; and Refocusing. Their Knowledge and Awareness levels of concerns were lowered as their knowledge increased as supported by the significantly greater scores on the achievement test. The attitudes of the teachers who participated were significantly increased in the direction judged to be positive when compared to the control group. In addition, the classes of students from the teachers who participated in the STS program achieved significantly higher scores on the teacher-made achievement tests than did the control. The results of this investigation indicate that a 10-day summer inservice workshop can be effective in reducing non- and beginning user teacher concerns, increasing content knowledge and approach tendencies toward STS topics. In addition, this information was successfully transferred to the students of the participating teachers.

[1] This research was partially supported by the Pennsylvania Science Teacher Education Program (PA STEP).

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INTRODUCTION

Science, Technology, and Society (STS) topics are presently being integrated into traditional school curricula throughout the United States. It is being recognized as a vital part of the educational training of our future citizens. "While some attention has always been given to teaching the human aspects of science, the STS movement is currently receiving an unprecedented breadth of support," (Aikenhead, Fleming, & Ryan,1987). And Roy (1984) adds "STS is not only here to stay, it is now reasonably certain that it will soon play a prominent role in American intellectual life."

The idea that an STS curriculum is important to the educational life of students has been promoted in "Educating Americans for the 21st Century (NSF, 1983):"

- Education in science and technology is of great importance to every individual who must cope with our technological world and take part in our democratic process.
- Education in science and technology is necessary to produce the scientists and engineers needed.
- Science and technology education is a "basic" for the modern world.
- There is an urgent need to extend and improve science and technology education in grades K to 12.

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"No pupil graduating from high school should be unaware of how STS shapes her/his life; hence, it is the secondary school level STS programs which are the cutting edge" (Roy, 1984). When asked who should take courses in which science and technology related problems are presented, 91.9% of science educators indicated they should be required of all students, and not just college bound students, or those planning to be scientists or engineers. The remainder, 8.1% indicated that courses in which STS topics are presented should be electives open to all students (Bybee, 1987). Many teachers consider the STS curriculum as important because it assures a focus on connections and applications of science to other parts of the curriculum and to the daily living of the students (Yager, 1987). Our students must learn to ask not only how to use the latest form of technology, but when and why to use it. Tomorrow's citizens must be able to make informed decisions that will affect their health and lifestyle and those of future generations (Kubichek, 1987). Bybee (1987), stated that education is one way of changing personal perceptions and public policies affecting these [STS] issues.

STS as a means of promoting technological literacy is being integrated into the educational systems of other countries as well. "Indeed given the nature of the world in which one lives, it would, perhaps, not be too grandiose to claim that STS is the core content of citizen education in every major country ... Moreover, it [STS] has sprung up simultaneously in dozens of places: it is not organized, there is no STS-society, no government agency pushing it. Yet it grows: it is truly a megatrend," (Roy, 1984). But, as stated by Rosenthal (1979), the need for change in the emphasis of science education is very real. "Although interest in science and society issues among educators seems widespread, it appears to us

that in practice science education is still geared more to the education of future scientists than to the needs of future citizens, " (Rosenthal, 1979).

The inservice treatment followed instructional models developed by the Research and Development Center for Teacher Education at the University of Texas at Austin. The Concerns Based Adoption Model (CBAM) (Hall, George & Rutherford, 1977) has been successfully used by others for the implementation of Energy Education Curriculum, (Ellis & Zielinski, 1983; Zielinski & Bethel, 1986).

> The argument for the applicability of current Environmental Education [EE] research to the area of STS Education is based upon similarities in goals across the two areas. Both EE and STS Education seek to aid citizens on developing the knowledge, skills, and attitudes to make responsible decisions on issues arising from their respective areas, and to take actions on those decisions. To those ends,each area has as its ultimate goal the preparation of citizens who are willing and able to take responsible actions. Thus, until research in STS education shows differently, curricular and instructional assimilance can be safely assumed.... As argued here, environmental education research provides an excellent base of knowledge on which to launch STS Education. Nonetheless, the continued growth and strength of STS Education will depend upon the corresponding growth and strength of STS Education research, (Rubba & Wiesenmayer, 1985).

Current references of inservice programs using the CBAM model in conjunction with STS education programs were not found. However, the Pennsylvania Science Teacher Education Project has conducted three prior STS workshops and found evidence which indicated the effectiveness of 10-day STS inservice programs on acquisition of knowledge and attitudes of participating students (Mechling, 1986 & 1987). Only descriptive statistics and anecdotal comments were available from these reports.

The purpose of this investigation was to determine the effects of a 10-day summer inservice education program on the stages of concerns (SoC), attitudes, and knowledge of selected STS concepts by secondary science inservice teachers. In addition, and most importantly, the impact of this inservice program was evaluated in terms of the ultimate impact on the knowledge of the students of the participating teachers.

The results of this study will be useful for planning future inservice programs in STS education. Specifically, this investigation addressed the following research questions:

R_1 Will a 10 day inservice education program for inservice science teachers alter their classroom behaviors such that their students will significantly increase their knowledge of selected STS concepts?

R_2 Will a 10-day inservice program positively impact the stages of concerns of the participating inservice science teachers?

R3 Will a 10-day inservice program significantly increase the attitudes of the participating inservice science teachers in a positive direction?

R4 Will a 10-day inservice program significantly increase the knowledge of selected STS concepts of the participating inservice science teachers?

METHODS & INSTRUMENTATION

This investigation used a non-randomized pretest-posttest, control group design (Isaac & Michael,1980). See Table 1. The variables of interest were the impacts of the inservice workshop on stages of concerns, attitudes, and knowledge of the inservice teachers, as well as the ultimate impact of the teachers' classroom behaviors (inferred) on their students' knowledge of selected STS concepts. This investigation used a volunteer teacher sample, n=22 experimental and n=17 control. The

classes of students of these teachers, save mortality, were used for the collection of student data (n=11 experimental and n=9 control). The differences in the numbers of teachers and classes (mortality) was a result of participants not currently employed, or teachers who evaluated their classes through means other than knowledge e.g. attitudes, concept mapping, papers/projects, and presentations.

The experimental group subjects for this investigation secondary science teachers from western Pennsylvania. The subjects were selected from a list of applicants for the summer inservice program. The participants were selected on the basis of a statement of need (graduate credit, permanent certification, pay raises, etc.) and proposed use of the information presented in the summer inservice program written on the application. Some minor consideration was given to the distance they would have to commute to the inservice program. These secondary inservice science teachers represented all disciplines of science. The experimental group teachers averaged eight years of teaching experience. Forty-seven per cent of them had master's degrees. Each of the teachers in the experimental group selected a teacher from their own school, grade level and subject area to serve as the control group. These teachers averaged 9.27 years of teaching experience and 39% of them had achieved master's degrees. Both the experimental and control groups were equally represented by males and females. The students of these control-group teachers served as the control group for the student data analysis.

The pretest data were collected on the first day of the inservice program. The posttest data were collected 10 days later following the inservice program. The data were collected on the control group by the participating inservice teachers using a similar time interval between

testings. The groups were not pre- and posttested at the same time due to the unavailability of the control teachers during the summer.

Four instruments were utilized to gather data for this investigation. The Stages of Concerns Questionnaire (Hall, George, & Rutherford, 1979) was an instrument with established reliability (Table 2) and validity. The instrument is a 35-item, forced-choice questionnaire developed to measure concerns of teachers who are implementing a curricular innovation. The instrument was developed and normed over a period of six years using inservice teachers. As individuals move from unawareness and nonuse of an innovation into beginning use and more highly sophisticated use, it was hypothesized that their concerns develop from being most intense at stages 0, 1, and 2, to most intense at stage 3, and ultimately to most intense at stages 4, 5, and 6, (Hall, et. al., 1979). These stages of concerns are more fully explained in Figure 1.

Responses to items on the Stages of Concerns Questionnaire were hand scored using "A Quick Scoring Device for the Stages of Concern Questionnaire." Group means were calculated and the results converted into percentiles and plotted as profiles (Figures 2 & 3). Covariant analysis ANCOVA, as recommended by Borg & Gall (1987), was used to evaluate the raw data group means of each of the six stages of concern using the pretest scores as the covariate. The level of significance was set at the .05 level.

The Test Of Science, Technology and Society Education was developed by the investigators. This instrument was a 50-item, multiple choice instrument. Each item consisted of a stem and five-answer choices. Items were submitted by content area experts presenting information during the inservice program, therefore, content validity was

assumed. The correlation coefficients relating to stability over time (test-retest) and internal consistency are presented in Table 3. For complete developmental information, see Zielinski, Bernardo, and Zamzow (1988). Covariant analysis (ANCOVA) as recommended by Borg and Gall (1983), was used to evaluate the pre- and posttest group means using the pretest subscales as the covariates. The level of significance was set at the .05 level.

The Science Technology and Society Attitude Scale was developed by the investigators one year prior to this investigation. Discriminatory aspects of the instrument were established using several groups with differing educational levels and demonstrated efforts concerning environmental problems. Reliabilities were determined by the collection of data from a volunteer group of inservice science teachers not likely to be involved with the inservice program. By using these teachers, the experimental group was not likely to be contaminated. Test-retest reliability was calculated using Pearson product-moment procedures. Test-retest reliability was found to be r= .77, (n= 45). Internal consistency was estimated using Kuder-Richardson 20 procedures. The internal consistency estimate was found to be r= .75, (n= 45). Detailed development information can be found in Zielinski, Bernardo, and Zamzow (1988b). The responses to the items were marked on mark-sense answer sheets, scored and, statistically analyzed by computer. Covariant analysis ANCOVA, as recommended by Borg & Gall (1983), was used to evaluate group means using the pretest scores as the covariates. The level of significance was set at the .05 level.

The student knowledge quizzes were teacher-developed instruments. Each teacher designed a test which best represented the curricula which

they had implemented. Thus, there were, in fact, many teacher knowledge tests. Therefore, no claims of reliability or validity can be claimed by the investigators, save the face validity of the items reported by the participating teachers. The teachers reported the class means resulting from the administration of these tests to the investigators. These raw scores were transformed into percentages. The percentages were normalized, via an arcsine transformation (Sokal & Rohlf, 1981). Covariant analysis ANCOVA, as recommended by Borg & Gall (1983), was used to evaluate the intact group normalized means of the classes of students using the normalized pretest class mean scores as the covariate. The level of significance was set at the .05 level.

THE INSERVICE & STUDENT TREATMENTS

The inservice treatment consisted of a 10-day workshop. Approximately 70 hours of instruction were provided. The instruction was approximately 40% information presentation, as directed by the results of the SoC pretest data analysis, e.g. the participants' peak stages of concerns were at the Awareness and Informational levels. This finding resulted in the tailoring of the presentation to meet the reported need for information and awareness. These analyses were supported by the relatively low scores on the Test Of Science Technology & Society Education pretest. These presentations were performed by the instructor (50%) and by experts (50%) in various fields. The remainder of the instructional time (60%) was utilized to provide hands-on experiences with laboratory investigations (75%) e.g. Making nylon, determining the sulfur content in dried foods, water chemical and biological analyses, and curriculum development (25%).

Topics were selected for inclusion in the inservice curricula after reviewing suggestions of Bybee, (1987); Science, Technology, Society, (NSTA,1985); & Educating Americans For the 21st. Century, (NSF,1983). These topics included: Acid Rain, AIDS, Carcinogens, Energy, Food Additives, Greenhouse Effect, Nuclear Energy and Fuel Cycle, Ozone, Pesticides, Radon Gas, Remote Sensing: Medical and Geological Applications, Solid Waste, Superconductivity, and Water Pollution.

Pedagogy was determined through a review of the above sources. Included were: Computer-Based Instruction, Discussion Leading Skills and Experiences, Field Experiences, Laboratory Experiences, Presentation of Content, Science Inquiry and Process Skills, and Role Playing and Simulation Activities.

Each secondary science students' treatment was tailored to the individual teacher. Each participant was assigned to develop and deliver a 10-day STS unit for their students. These curricula were taught for ten days in their classrooms from approximately one to three months after the completion of the workshop. The content and methodology of the STS units were evaluated by the investigators. They were judged to be modeled in content, process, and pedagogy after those presented in the summer inservice workshop. It was the delivery of these STS units which comprised the treatment given to the students participating in the experimental group of this investigation. The actual treatment given to these students was only inferred from the written lesson plans submitted by the teachers. The actual classroom instruction was not observed. The teachers met in a one-day follow-up session following the semester in which the STS curriculum was taught. Information gathered in this session and notes required on their lesson plans indicating changes made

resulted in no evidence of substantial changes made in the planned lessons.

RESULTS

The data for this investigation were collected from volunteer inservice secondary science teachers and their students. The results will be divided into four sections. The first section will be Research Question one, the results of the analysis of the data from the students. This section is the least rigidly controlled, but perhaps the most educationally important.

The first research question was evaluated using ANCOVA at the .05 level of significance. The intact group means (in percents) were adjusted for normality using an arcsine transformation technique (Sokal & Rohlf, 1981). The pretest mean scores were used as a covariate to adjust the posttest mean scores. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus, the assumption of homogeneity of variance was not violated (Statsoft,1985). The value resulting from this test $F = 35.5$, $df = 1,17$, exceeded the critical value necessary for statistical significance. The level of significance found by this analysis was in excess of .000. See Tables 4 and 5.

The data gathered on the participating teachers' stages of concerns were used to evaluate the second research question. The mean scores for each stage of concern were calculated. These data are presented in Table 6. Profiles comparing the mean pre- and posttest stages of concerns of both the experimental and control groups were constructed and are presented in Figures 2 & 3. In addition, the data were subjected to ANCOVA

statistical analyses as suggested by Borg & Gall (1987). These results are presented in Tables 6 & 7.

Interpretation of the Stages of Concerns Questionnaire was accomplished through several methods. First was the peak and second highest peak score method. Peak scores can be interpreted directly from the SoC definitions provided in Figure 1. Second was the profile interpretation. As individuals move from unawareness and nonuse of an innovation into beginning use and more highly sophisticated use, it was hypothesized that their concerns develop from being most intense at stages 0, 1, and 2, to most intense at stage 3, and ultimately, to most intense at stages 4, 5, and 6, (Hall, et. al., 1979). When plotted, the progression appears as a wave progressing from left to right as the growth of an individual or group is assessed.

Because it was important to determine educational significance as well as statistical significance in this educational study, two kinds of results will be presented for the stages of concerns data. The developers of the Stages of Concerns Questionnaire have determined that 10 percentile points represented an educationally important finding, these data will be presented along with the results of the ANCOVAs.

The SoC score on the Awareness Stage (0) was reduced for the experimental group by 23 percentile points while it increased two percentile points for the control group. Analysis of Covariance showed that the reduction of awareness concerns was statistically significant between the groups at the .05 level of significance ($f = 45.91$, $df = 1,36$). See Tables 6, 7, & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus,

the assumption of homogeneity of variance was not violated (Statsoft,1985).

The SoC score on the Informational Stage (1) was reduced for the experimental group by 23 percentile points, while it was reduced by eight percentile points for the control group. Analysis of Covariance showed that the reduction of informational concerns was statistically significant between the groups at the .05 level of significance ($F = 11.85$, $df = 1.36$). See Tables 6, 7, & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded significant results at the .05 level, thus, the assumption of homogeneity of variance may have been violated, therefore, results need to be viewed with some caution (Statsoft,1985).

The SoC score on the Personal Stage (2) was reduced for the experimental group by 23 percentile points, while it increased four percentile points for the control group. Analysis of Covariance showed that the reduction of personal concerns was not statistically significant between the groups at the .05 level of significance ($f = 3.33$, $df = 1,36$). See Tables 6, 7, & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus, the assumption of homogeneity of variance was not violated (Statsoft,1985).

The SoC score on the Management Stage (3) was increased for the experimental group by four percentile points, while it increased nine percentile points for the control group. Analysis of Covariance showed that the change of management concerns was not statistically significant between the groups at the .05 level of significance ($f = .05$, $df = 1,36$). See Tables 6, 7, & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level,

thus, the assumption of homogeneity of variance was not violated (Statsoft,1985).

The SoC score on the Consequence Stage (4) was increased for the experimental group by 28 percentile points while it increased two percentile points for the control group. Analysis of Covariance showed that the increase of consequence concerns was statistically significant between the groups at the .05 level of significance ($f = 16.96$, $df = 1,36$). See Tables 6, 7, and 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded significant results at the .05 level, thus, the assumption of homogeneity of variance May have been violated, ergo the results need to be viewed with some caution (Statsoft,1985).

The SoC score on the Collaboration Stage (5) was increased for the experimental group by 29 percentile points while it increased six percentile points for the control group. Analysis of Covariance showed that the increase of collaboration concerns was statistically significant between the groups at the .05 level of significance ($f = 29.05$, $df = 1,36$). See Tables 7 & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded significant results at the .05 level, thus, the assumption of homogeneity of variance may have been violated, thereby, the results need to be viewed with some caution (Statsoft,1985).

The SoC score on the Refocusing Stage (6) was increased for the experimental group by 43 percentile points while it increased nine percentile points for the control group. Analysis of Covariance indicated that the increase of refocusing concerns was statistically significant between the groups at the .05 level of significance ($f = 26.54$, $df = 1,36$). See Tables 7 & 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus,

the assumption of homogeneity of variance was not violated (Statsoft,1985).

Research question three was evaluated using ANCOVA at the .05 level of significance. The pretest mean scores on the attitude measure were used as a covariate to adjust the posttest mean scores. The value resulting from this test F= 9.30, df= 1,35 exceeded the critical value necessary for statistical significance at the .05 level. See Table 8. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus, the assumption of homogeneity of variance was not violated (Statsoft,1985).

Research question four was evaluated using ANCOVA at the .05 level of significance. The pretest mean scores on the knowledge test were used as a covariate to adjust the posttest mean scores. The value resulting from this test F= 78.38, df= 1,35, exceeded the critical value necessary for statistical significance at the .05 level of significance. See Table 9. Statistical comparison of the pooled variance estimate of the pretest scores yielded nonsignificant results at the .05 level, thus, the assumption of homogeneity of variance was not violated (Statsoft,1985).

DISCUSSION

The conclusions which were drawn from this investigation were based upon the four research questions.

R_1 Will a 10-day inservice education program for inservice science teachers alter their classroom behaviors such that their students will significantly increase their knowledge of selected STS concepts?

The highly statistically significant values (see Table 5) found on the analyses of the posttest data from the student groups indicate that something happened to the experimental groups which resulted in increased learning of the selected STS concepts by the students of teachers who participated in the inservice workshop. Inspection of the descriptive statistics (Table 4) reveals the groups were similar on the pretest, but the students whose teachers had benefit of the inservice workshop scored an average of 13 normalized percentage points higher. These results indicate that an inservice workshop of10-day duration can impact the learning of pupils. However, no observations of the many variables which constituted the everyday happenings within a classroom were made. Inferences about these happenings were made by looking at the lesson plans submitted by the participating teachers. These plans indicated that the inservice participants modeled portions of the workshop in format and content in their classes.

R_2 Will a 10-day inservice program positively impact the Stages of Concerns of the participating inservice science teachers?

The intact group profiles of the experimental and control groups on the pretest indicate both groups were highest on the Awareness and Informational concerns. Both the experimental and control groups profiles most closely resemble the profiles of a nonuser (Figures 2 & 3). The posttest SoC profiles of the control group did not show much change. It is interesting to note, however, that all of the stages of concerns were elevated in this group. These changes may have been due to the effects of the pretest or the activities of the teachers and students who were involved in STS education.

The posttest profile of the experimental group most closely resembles that of an experienced user (Figures 2 & 3). This profile indicated that these teachers had less concerns about Awareness, Informational, Personal, and Management stages of concerns than the Consequence, Collaboration, and Refocusing stages of concerns. This profile closely resembles that found by Hall, George, & Rutherford (1979). This change in a short (relatively) time frame was possibly due to the amount of "hands-on" experience the participants received during the workshop.

The statistical analyses revealed that five of the seven stages of concern were altered by an amount which was both statistically and educationally significant. The significant decreases in the Awareness and Informational stages of concerns was further supported by the statistically significant increases of posttest scores on the Test of Science Technology and Society Education. These results indicated the workshop format had the desired impact on the sample. The control groups informational concerns were lowered eight percentile points (not educationally significant). This, however, may reveal some learning from the pretest or that interaction occurred between the experimental group and the control group. Other plausible explanations include differentially-occurring history or maturation.

The reduction of the Personal (2) concerns on the posttest indicates the participating teachers had fewer concerns in relation to their involvement with STS topics in the curriculum. They had fewer concerns than the control group as well. This finding indicates that working (hands-on) with STS issues, curriculum and implementation models during the inservice program was successful at meeting the needs of the participants.

Management-level concerns were not significantly altered by the treatment. It was interesting to note that the control group Management concerns approached educational significance. It was possible these teachers, exposed to the happenings of their peers in the experimental group and their inability to score well on the knowledge and attitude instruments, began to have higher concerns related to the implementation of STS topics into their classes. Although these teachers were not currently teaching STS topics, these concerns may include the acquisition and application of information, as well as finding time to organize and infuse STS topics into their classes. This may be the effect of peer pressure.

The stage 4 (Consequence) concerns for the experimental group were increased significantly from both statistical and educational perspectives. This indicated this group was becoming concerned with the impact that STS education was having on their students. These concerns focus on increasing the relevance of their teaching, including methods and content, and the evaluation of their students' performance. Consequence concerns were not affected in the control group. The transition of concerns from self and task to impact was not made.

The Collaboration concerns (stage 5) were significantly raised in the experimental group, while there was little impact on the control group. This indicated the teachers in the experimental group were becoming more concerned with working with others to integrate STS topics into the curriculum effectively. The desire (increased concern) of the experimental group to collaborate may help to explain the increases in concerns at the Management level and the decrease of Informational concerns within the control group. Collaboration may have begun prior to post-

testing. There was, however, no evidence to support this hypothesized collaboration.

The Refocusing concerns (stage 6) showed the greatest gain of all stages in the experimental group. These elevated concerns indicated the inservice teachers were concerned with exploration of methods to make STS education more powerful. Developing new lessons, adapting new methodologies and revising old curricula are examples of these methods. The control group posttest scores also increased, albeit not significantly, on this stage of concern. Perhaps the mechanisms mentioned above were at work in this area as well.

R_3 Will a 10-day inservice program significantly increase the attitudes of the participating inservice science teachers in a positive direction?

The significant results of the ANCOVA between the experimental and control group scores on the posttest Science, Technology and Society Attitude Scale indicated the inservice program was successful. The inservice program resulted in the participants having more positive approach tendencies (Mager, 1984), in regard to STS education. These might include thinking about, speaking favorably with others about, or moving towards implementation of STS curricula.

R4 Will a 10-day inservice program significantly increase the knowledge of selected STS concepts of the participating inservice science teachers?

The significant results of the ANCOVA between the experimental and control group scores on the posttest of the Test of Science, Technology and Society indicated the inservice program was successful for the acquisition of knowledge. The inservice program resulted in the participants

having significantly more knowledge of the STS concepts presented than prior to the inservice program, or than their peers in the control group who had no inservice program.

The results of this investigation confirms that methodology used for the presentation of inservice programs in the Energy Education decade are appropriate for STS education as well. In addition, The Concerns Based Adoption Model seems well suited for STS curriculum implementation inservice programs. This investigation revealed practical methods of implementing STS topics into secondary science curricula through teacher education resulting in knowledge gains by both inservice teachers and their students, more positive attitudes by inservice teachers, and inservice teacher concerns focused on student impact and improvement of curricula when compared to their peers in the control group who had no inservice program.

Research concerning this topic is ongoing, including the improvement of the knowledge and attitude instruments. Researchers replicating this study may wish to consider adding a teacher observation component. Observation would assist in identifying and quantifying behaviors in the classroom which contribute to the students' learning. In addition, observation of teachers would identify the components modeled in the inservice program utilized by the participants in their classrooms.

REFERENCES

Aikenhead, G. S., Fleming, R. G. & Ryan, A. G. (1987). High-school graduates' beliefs about science-technology-society. 1. Methods and issues in monitoring student views. Science Education, 71 (2).

Borg, W. R., & Gall, M. D. (1983). Educational Research, Fourth ed. White Planes, New York. p. 667.

Bybee, R. W., (1987, April). Teaching about science technology-society (STS): Views of science educators in the United States. School Science and Mathematics, 87, (4), pp 274-285.

Education Commission of the States, (1978). Assessment of science 1976-1978. National Assessment of Educational Progress.

Ellis, J. D. & Zielinski, E. J., (1983, April). Effects of a summer institute on middle school teachers' energy knowledge and attitudes and energy education implementation. Paper presented at the National Association for Research on Science Teaching Annual Convention, Dallas Texas.

Hall, G. E., George, A. A., & Rutherford, W. L., (1979). Measuring stages of concern about the innovation: A manual for use of the SoC questionnaire. The University of Texas at Austin.

Isaac, S. & Michael, W. B., (1980). Handbook in research and evaluation. San Diego, Ca, EdITS Publishers.

Kubichek, J. (1987). Putting science in context, Science Scope, 11 (2).

Mager, R. F., (1984). Developing attitude toward learning. Belmont, Ca, David S. Lake Publishers.

Mechling, K. R. (1986,1987) Pennsylvania science teacher education program: summary report. Harrisburg, Pa. Report to the Pennsylvania Higher Education Assistance Agency, .

National Science Foundation, (1983). Educating Americans for the 21st century. Washington, DC. The National Science Board Commission on Precollege Education in Mathematics, Science And Technology.

Science, Technology, Society (1985). Washington, DC. Yearbook of the National Science Teachers Association. NSTA.

Statsoft (1985). Tulsa, Ok. Users manual for Statfast 2.1. Statsoft Corp. p. 112.

Rosenthal, D. B., (1979). A science and society course for high school students. The American Biology Teacher, 41, (6), pp. 336-340.

Roy, R., (1984). STS: The Megatrend in Education. Proceedings of the 1984 International Congress on Technology and Technology Exchange, Pittsburgh, Pa.

Rubba, P. A. & Wiesenmayer, R. L., (1985). The implications of recent research in environmental education for science-technology-society education. The Pennsylvania State University. Manuscript submitted for publication.

Sokal, R. R. & Rohlf, F. J., (1981). Biometry. W. H. Freeman and Company, U.S.A.

Yager, R. E., (1987, October). Assess all five domains of science. The Science Teacher. 54,7. p 33-37.

Zielinski, E. J., & Bethel, L. J., (1986). A comparison of two science inservice models on teachers' acquisition of selected energy concepts and stages of concern as a function of their level of

activity. (Doctoral dissertation, University of Texas at Austin, 1986). Dissertation Abstracts International. 47, 12, p. 4348a.

Zielinski, E. J., Bernardo, J. A., & Zamzow, S. K. (1988a). The development of an instrument to assess knowledge of science, technology and society concepts of secondary inservice science teachers. Paper presented at the National Science Teacher Regional Convention, Columbus, Ohio, October 20, 1988.

Zielinski, E. J., Bernardo, J. A., & Zamzow, S. K. (1988b). The development of an instrument to measure attitudes toward science, technology and society topics of secondary inservice science teachers and middle school science students. Paper presented at the National Science Teacher Regional Convention, Columbus, Ohio, October 20, 1988.

Table 1
Experimental design

Group	Pretest	Treatment	Posttest
Experimental	$O_{1,2,3,4}$	X	$O_{1,2,3,4}$
Control	$O_{1,2,3,4}$		$O_{1,2,3,4}$

O_1 Test of Science Technology & Society

O_2 Stages of Concern Questionnaire.

O_3 Science, Technology and Society Attitude Scale

O_4 The Student Knowledge Quizzes

Table 2
Reliability of the "SoC Questionnaire"

Stage	Awareness 0	Informational 1	Personal 2	Management 3	Consequence 4	Collaboration 5	Refocusing 6
Alpha N = 830	.64	.78	.83	.75	.76	.81	.71
Test-retest N = 132	.65	.86	.82	.76	.76	.84	.71

Table 3
Reliability: "Test of Science, Technology and Society Education" and "The Science Technology and Society Attitude Scale"

SCALE	Items	Pearson r	K-R 20	N
Knowledge (TSTS)	50	.84	.82	14
Attitude (TSTSAS)	45	.77	.75	45

Table 4
Descriptive statistics for the teacher and student groups

GROUP	N	PRETEST MEANS	SD	POSTTEST MEANS	SD	ADJUSTED MEANS
Student Experimental Intact Groups, Knowledge	11	43.63	8.56	57.48	10.97	57.95
Student Control Intact Groups, Knowledge	9	44.69	9.46	44.60	8.68	44.03
Teacher Experimental						
Knowledge	24	20.38	3.82	36.92	6.06	36.16
Attitude	22	169.82	9.47	179.27	6.77	180.13
Teacher Control						
Knowledge	14	19.86	4.28	20.07	4.73	20.16
Attitude	16	174.06	11.69	179.27	6.77	170.50

Table 5
ANCOVA of posttest mean scores between the student groups on the teacher-made knowledge tests.

Effect	df	MS	F	P
Covariate	1	1349.67	50.25	.000
A	1	954.41	35.54	.000
Within	17	26.86		

Table 6
SoC mean percentile scores

Source	Stage	Awar. 0	Info. 1	Pers. 2	Man. 3	Cons. 4	Coll. 5	Ref. 6
Experimental	pre	89	92	86	56	48	55	30
Experimental	post	66	69	63	60	76	84	73
Change within		-23*	-23*	-23*	+4	+28*	+29*	+43*
Control	pre	94	83	72	47	24	22	17
Control	post	96	75	76	56	26	28	26
Change within		+2	-8	+4	+9	+2	+6	+9

* A 10 percentile change is considered educationally significant by the developers of the SoC.

Table 7
ANCOVA of posttest scores between groups on the stages of concerns subscales

Effect	df	MS	F	P
Awareness	1	700.08	45.91	.000
Informational	1	302.82	11.85	.002
Personal	1	189.08	3.33	.07
Management	1	1.58	0.05	.81
Consequence	1	692.09	16.96	.000
Collaboration	1	616.20	29.05	.000
Refocusing	1	1069.15	26.54	.000

Table 8
ANCOVA of posttest scores on The Science, Technology and Society Attitude Scale.

Effect	df	MS	F	P
Covariate	1	914.18	10.31	.003
A	1	824.31	9.30	.005
Within	35	88.68		

Table 9
ANCOVA of posttest scores on the Test of Science, Technology and Society Education

Effect	df	MS	F	P
Covariate	1	38.67	1.23	.27
A	1	2458.98	78.38	.000
Within	35	31.37		

Figure 1
Stages of Concern About the Innovation[2]

0 AWARENESS: Little concern about or involvement with the innovation is indicated.

1 INFORMATIONAL: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about herself/himself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.

2 PERSONAL: Individual is uncertain about the demands of the innovation, Her/his inadequacy to meet those demands, and her/his role with the innovation. This includes analysis of her/his role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.

3 MANAGEMENT: Attention is focused on the process and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.

4 CONSEQUENCE: Attention focuses on impact of the innovation on students in her/his immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.

5 COLLABORATION: The focus is on coordination and cooperation with others regarding use of the innovation.

6 REFOCUSING: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. The individual has definite ideas about alternatives to the proposed or existing form of the innovation.

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[2] Original concept from Hall, G. E., Wallace, R. C., Jr., & Dossett, W. A. A developmental conceptualization of the adoption process within educational institutions. Austin: Research and Development Center for Teacher Education, The University of Texas, 1973.

Figure 2
STAGES OF CONCERNS PROFILE: CONTROL GROUP MEANS

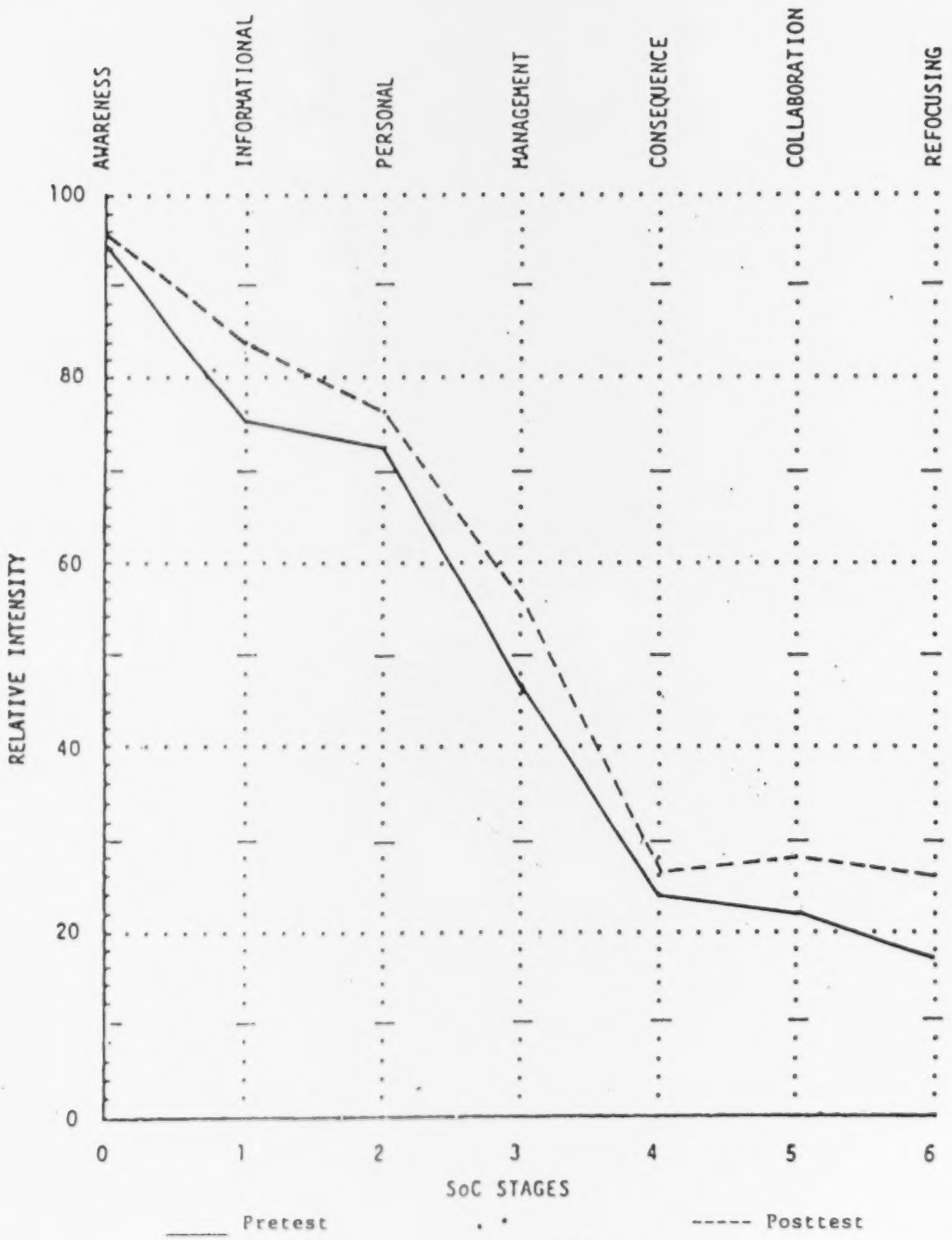

Figure 3
STAGES OF CONCERNS PROFILE: EXPERIMENTAL GROUP MEANS